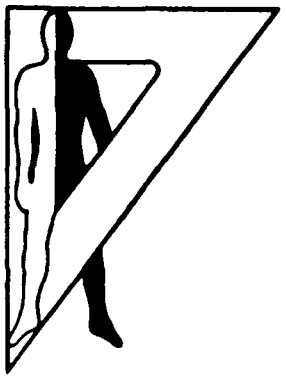

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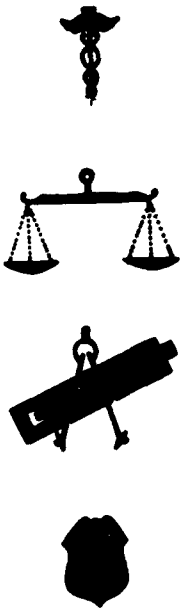
Technical Memorandum 21-75

TESTING AND EVALUATION OF CHEMICAL WEAPONS



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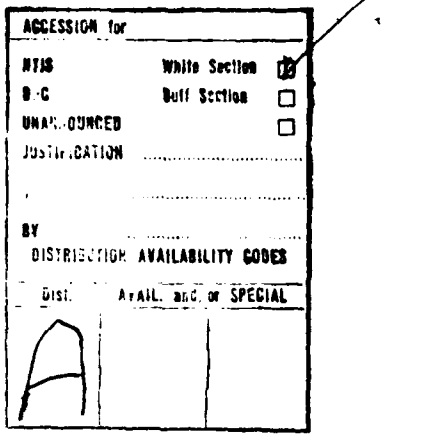
Donald O. Egner
Donald Campbell

August 1975
AMCMS Code 960000

U. S. ARMY HUMAN ENGINEERING LABORATORY

Aberdeen Proving Ground, Maryland



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Representative chemical-riot-control-agent dispersing devices were selected and tested to obtain results that could guide further development of the effectiveness models for chemical less-lethal devices. Testing techniques and results obtained are discussed.

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Technical Memorandum 21-75

TESTING AND EVALUATION OF CHEMICAL WEAPONS

Donald O. Egner
Donald Campbell

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CONTENTS

PREFACE

The work described in this report was performed under Task Plan VIII of the Law Enforcement Assistance Administration/U. S. Army Human Engineering Laboratory Interagency Agreement No. LEAA-J-IAA-014-2. Mr. Lester Shubin was the Law Enforcement Assistance Administration Program Manager for this task.

This report essentially contains information and data gathered to assist in the development of the evaluation technique for chemical less-lethal weapons and as input to the evaluation models. The utilization of these and other data for the evaluation of certain chemical devices is given in the report submitted under Task IV (Modeling for Less Lethal Chemical Devices) of the basic Law Enforcement Assistance Administration/U. S. Army Human Engineering Laboratory Agreement.

The following organizations contributed in part to the work reported here:

Biomedical Laboratory of Edgewood Arsenal

AAI Corporation

H. P. White Laboratory

EXECUTIVE SUMMARY

Four series of field tests were conducted to obtain quantitative measurements needed to assist in the design and/or exercise of the evaluation models developed for less-lethal chemical weapons. Representatives from each of the three main categories of chemical dispersing devices were selected, procured and tested to obtain the required data. Several techniques for collecting data were considered before arriving at the actual procedures used.

As an addition to the data gathered from literature searches, these four series of tests provided information to: help establish a model for hand-held pressurized projectors (Projector Model); verify the validity of the model for inclosures (Ventilation Model); verify the Projector Model; and provide input for the Projector and Ventilation Models.

Altogether, six types of hand-held pressurized projectors, two types of 12-gauge barricade penetrators, one type of grenade and one gas gun projectile were tested.

Results of these tests are documented in this report.

TESTING AND EVALUATION OF CHEMICAL WEAPONS

INTRODUCTION

The existing chemical dispensing devices which are either already being used by law enforcement agencies, or which hold promise as being potential candidate weapons for their use, may be grouped into three main categories, viz., (1) projectors, (2) grenades, and (3) projectiles.

The chemical projectors are pressurized dispersers and include the hand-held aerosol and liquid dispensers, foggers, smoke cords, chemical wands, etc. The chemical grenades dispense their agent by functioning as either burning-type, bursting-type, or compressed-gas type agent ejectors. Some grenades are designed to be hand-held, some to be hand-thrown, some to be gun-launched, and some to permit the option of choosing any one of these delivery methods. Projectiles, like the grenades, function as either burning-type, bursting-type, or compressed-gas type agent ejectors. As the name "projectile" implies, projectiles are impelled to desired target areas by guns or launchers.

In the course of developing a mathematical model for predicting the effectiveness of chemical weapons in law-enforcement roles, some device testing is required to obtain the quantitative measurements needed to assist in the design and/or exercise of the model.

This task had three primary objectives, all related to and in support of a companion task (Task IV) on modeling for chemical devices and conducted under the same basic Interagency Agreement between the Law Enforcement Assistance Administration (LEAA) and the U. S. Army Human Engineering Laboratory (USAHEL). These three objectives were:

1. Gather data which would assist in developing the model.

2. Develop techniques of testing which would provide necessary data with minimum expenditure of effort or funds.

3. Obtain sample input data to be used in the evaluation models.

A survey of the chemical-agent dispersing devices currently being used by law-enforcement personnel makes it apparent that procuring and testing each available device in quantities sufficient to form a reliable statistical sample would be precluded by both economic and level-of-effort considerations. Consequently, chemical dispersing devices for testing were chosen to include a reasonable, representative sample from each of the three main categories of the available chemical dispersing devices, and to provide data not found in the literature.

Chemical Device Tests

General

a. This report describes the tests and presents the results obtained for those representative chemical dispersing devices chosen for testing. The scope of the tests conducted is summarized in Table 1. It will be noted that emphasis was given to hand-held pressurized projectors and to projectiles; grenades were considered to some degree previously under Task III of the LEAA/USAHEL Agreement. That work is described in a draft report entitled "The Effectiveness of Less Lethal Weapons Utilizing Chemical Agents," and dated May 1974.

TABLE 1

Summary of Test Plans

Test Series	Measurement	Test Site	Items Tested
1	a. Amount of Agent Deposited b. Vapor Samples	Biomedical Laboratory Wind Tunnel (Edgewood Arsenal, MD)	Chemical Mace MK IV Federal Streamer 280 Penguin Chemical Billy AG-20
2	Aerosol Samples	Test Chamber at H. P. White Laboratory, Bel Air, MD	12-Gauge Smith & Wesson Truflite MK II AAI Ferret SGA 100 Federal 514 Grenade Federal Flite Rite 530
3	a. Aerosol Samples b. Vapor Samples	Test Chamber at H. P. White Laboratory, Bel Air, MD	Chemical Mace MK IV Federal Streamer 280 Penguin Chemical Billy AG-20 DPC Paralyzer
4	Time to Hit Orbital Area of Target	Test Site at U.S.Army Human Engineering Laboratory, Aberdeen Proving Ground, MD	Federal Streamer 280 DPC Paralyzer Penguin Stinger Army Experimental Device (XM36)

b. The techniques of measurement to be described represented the simplest means of obtaining the data required for the evaluation models prepared for these types of chemical weapons. The names of the specific evaluation models developed under the chemical modeling task references above and the required input data for each are given in Table 2. Although there are different ways to obtain estimates of these input data (data such as concentration, for example), an overall objective of this task was to make field measurements of some of these values.

c. The first series of tests was designed to measure both the amount of agent deposited on a target and the concentration of vapor emanating from the area of deposition. The second and third series of tests were designed to measure the airborne concentrations of agent produced by the functionings of selected devices. Series number four was designed to obtain estimates of the times taken to hit the orbital area of a person using selected hand-held, hand-actuated pressurized projectors.

d. Aerosol samples were collected on Gelman type A glass fiber filter pads, and the agent was extracted from the pads with absolute ethanol. Vapor samples were collected in glass bubblers containing fifteen milliliters of absolute ethanol.

TABLE 2

Specific Evaluation Models And Required
Weapon Performance Input Data

Model Name	Input Data	Scenario Usage[a]
Projector Model	Hit Accuracy in Terms of Time	One-On-One
Ventilation Model	Concentration Ventilation Rate	Barricade and Hostage
Cloud-Travel Model	Source Strength Meteorological Parameters (Wind Speed and Diffusion Coefficients)	Dispersal of a Crowd

[a]Basic Scenarios for Evaluation are described in the Task I Draft Report of the Law Enforcement Assistance Administration/U.S. Army Human Engineering Laboratory Basic Agreement, entitled "A Multidisciplinary Technique for the Evaluation of Less Lethal Weapons", Vol. I, July 1973.

e. Chemical analyses for agent content in the ethanolic extracts were accomplished by measuring the ultraviolet absorption of the samples with a Beckman spectrophotometer and determining agent concentration from a standard curve developed for known concentrations. The optimum absorbance peak for CS is 300 mμ and, for CN, 246 mμ.

Test Series One

a. Series-number-one tests were conducted in the Environmental Toxicology Branch's wind tunnel at the Biomedical Laboratory, Edgewood Arsenal, Maryland. As previously stated, the object of these tests was to measure the amount of agent deposited on a target and the amount of vapor emanating from the area of deposition. The devices used for these tests were three hand-held, hand-actuated pressurized riot-control-agent projectors. A total of 12 tests were conducted—two "firers." each "fired" two shots with each device.

b. Two mannikins, each clothed in a butyl-rubber impermeable suit with a sateen surcoat placed over the suit, were set up in the wind tunnel, side by side, about 4 feet apart. A petri dish (9 square inches) was affixed to the chest area of each mannikin to serve as an impaction plate. Vapor samplers with intake probes situated at eye/nose level on both sides of each mannikin were actuated at the same time as the agent disperser and sampled at a rate of 1-liter-per-minute for 15 minutes. All "firings" were directed toward the petri dish for 3 seconds from an upwind distance of 6 feet. Surcoats, plates, and sampler solutions were changed for each shot. Winds were maintained at 2 miles per hour. The ambient temperature was 78°F., and the relative humidity was 42-46 percent. A listing of the devices tested in this series, device characteristics, test comments, and measured concentrations are presented in the Appendix as Tables 1A through 12A and are summarized in Table 3 below.

TABLE 3

Summary of Test Results for Hand-Held Pressurized Projectors
Fired at Mannikin Targets
(Three-Second Burst)

Type of Projector	Average Amount of CN Impacted on Plate (Milligrams)	Average CN Vapor Concentration in First 15 Minutes (Milligrams Per Cubic Meter)
Chemical Mace Mark IV	10.9	0.4
Federal Streamer No. 280	13.1	0.3
Penguin Chemical Billy AG-20	0.4	0.4

Test Series Two and Three

a. Series two and three tests were conducted at the H. P. White Laboratory, Bel Air, Maryland. The object of these tests was to measure the airborne concentrations produced by the devices. Series two differed from series three only in the type of dispersers used.

Agents were dispersed inside a box-type enclosure, constructed of ½-inch-thick plywood, of approximate dimensions 8 feet by 8 feet by 8 feet. The northern and southern walls were secured by clamps to permit their easy removal for access to samplers and to facilitate decontamination measures after each shot. A small glass window measuring approximately 9 inches by 11 inches was set in the eastern wall for devices and/or agents entry. The sash was designed to permit rapid replacement of window pane. The side opposite the window was locally fitted with a protective steel plate in line with the window, to keep the barricade-penetrating devices from penetrating the box's wall. The inside surfaces were sealed with wood sealer and several coats of white enamel. A photograph of the test chamber, from a position facing the window, is shown in Figure 1.

b. Two sampling stands were placed inside the enclosure, each about 2 feet from the western wall of the enclosure, with stand number one positioned about 2 feet from the southern wall and stand number two positioned about 2 feet from the northern wall. Intake probes were placed on each stand at 1 foot and 5 feet above floor level. Figure 2 is a photograph of the sampling stands positioned in the enclosure, with particulate samplers mounted. In this photograph, the protective steel plate can also be seen on the wall behind the sampling stands.

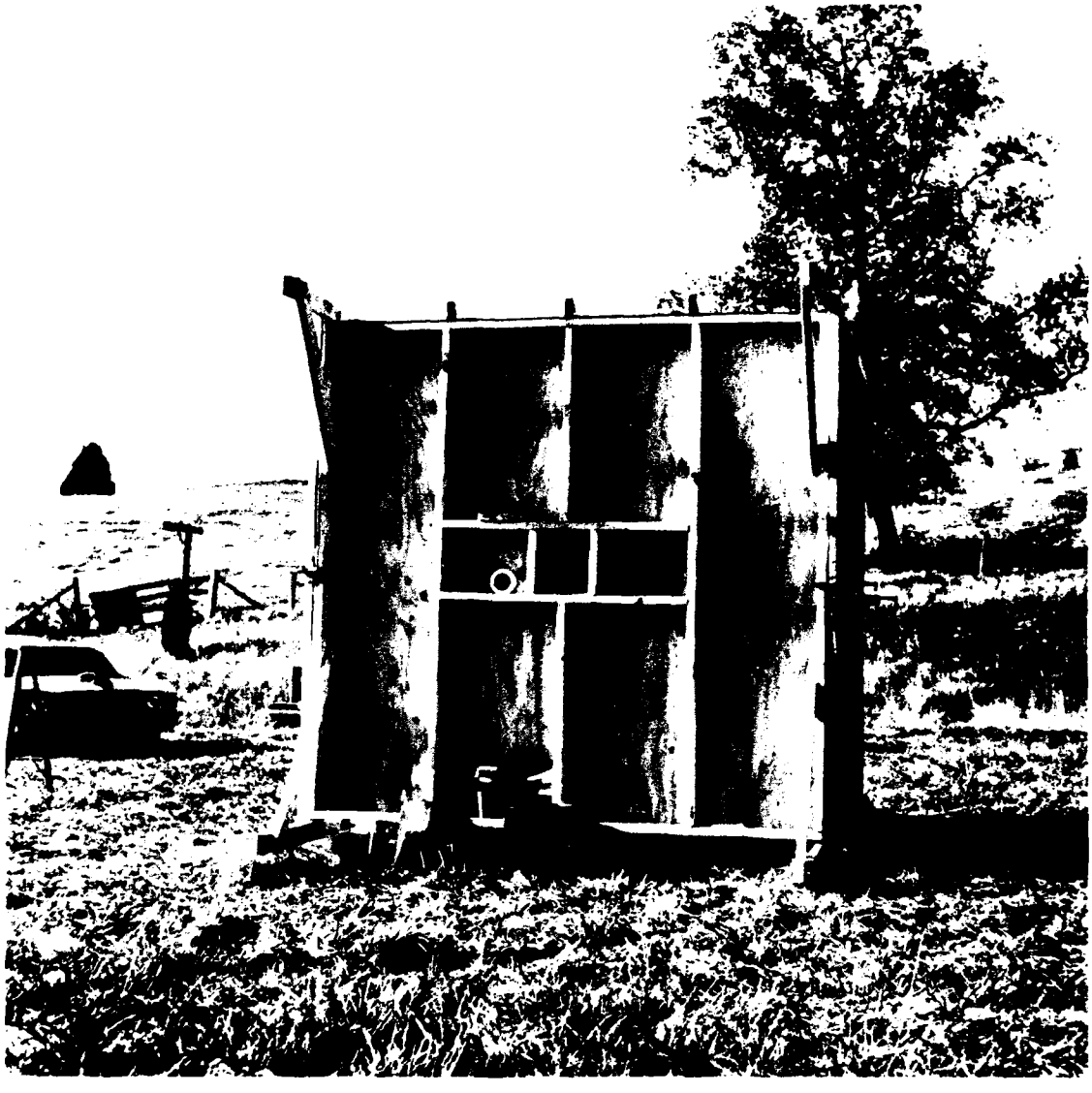

Fig. 1. Test chamber.

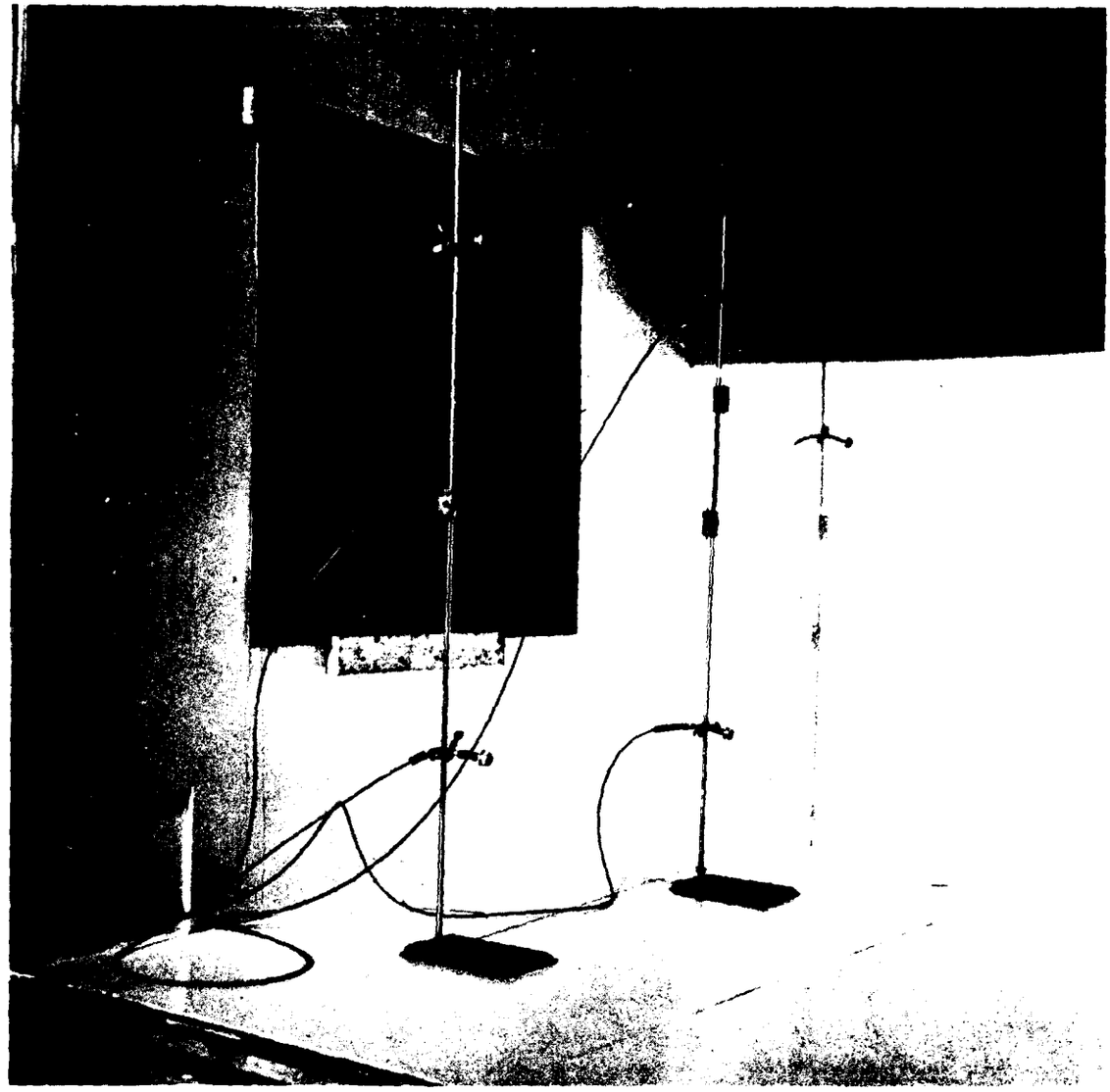

Fig. 2. Particulate samplers mounted on positioned stands.

c. Series number two tests were conducted with three types of barricade-penetrating devices and one type of grenade. A total of 13 firings were made—four with one type device, and three with each of the other three types of devices. The firer, an experienced gunner, fired from a standing position about 10 meters from the enclosure. All except two rounds went through the window (the two exceptions were the first and second firings of the 530 Flite-Rite Projectile; each of these went through the enclosure wall at almost precisely the same point—about 1 foot above the top of the window). After entry the devices disseminated their agent payloads within the enclosure. The hole produced by the device's entry was covered immediately after each shot, except for two cases—after the first round of the Smith and Wesson 12 Gauge Tru-Flite MK II, and after the first round of the Federal Flite-Rite 530 round.

d. Aerosol samplers were actuated immediately after the device entered the enclosure. Air samples were taken at a rate of 5 liters per minute for a total of 10 minutes (5 minutes by samplers on stand number one, followed by 5 minutes by samplers on stand number two). A summary of these results is given in Table 4. Test results and comments are presented in the Appendix in Tables 13A through 18A.

TABLE 4

Barricade-Penetrating Projectiles:
Average Airborne Concentration of Agent
During First Five Minutes
(Agent CS - 8 Ft. Cubic Inclosure - No Ventilation)

Type of Projectile	Average Concentration (Milligrams Per Cubic Meter)
12-Gauge Smith & Wesson Truflite Mark II	31
AAI Ferret SCA 100	22
Federal 514 Grenade	275
Federal Flite Rite 530	252

e. In test series number three, one each of four types of hand-held, hand-actuated, pressurized riot-control-agent projectors was emptied into the enclosure through the window, and then the window was immediately closed.

f. Both aerosol and vapor samples were collected during this series of tests. Samplers were actuated at the same time as a disperser, and sampling was continued for a total of 36 minutes (18 minutes by samplers on stand number one, followed by 18 minutes by samplers on stand number two). Aerosol sampling intake rate was 5 liters-per-minute, and vapor sampling intake rate was 1 liter-per-minute.

g. A listing of the devices tested, device characteristics, test comments, and test results are presented in the Appendix in Tables 19A through 22 A for the series 3 tests. Table 5 presents a brief summary of this data.

TABLE 5

Hand-Held Pressurized Projectors:
Average Airborne Concentration of Agent
During First Eighteen Minutes

Type of Projector	Agent	Concentration (Milligrams Per Cubic Meter)	
		Vapor	Aerosol
Chemical Mace Mark IV	CN	4	0
Federal Streamer No. 280	CN	5	0
Penguin Chemical Billy AG-20	CN	2	0
DPC Paralyzer	CS	0	1

Test Series Four

a. The fourth series of tests was conducted at the U. S. Army Human Engineering Laboratory test site to obtain estimates of the times taken to hit the orbital area of a person with hand-held, hand-actuated, pressurized chemical-riot-control-agent projectors.

b. To represent the orbital area, two 30-square-centimeter circular holes, separated by one-half inch were cut out of a piece of cardboard and, with the holes aligned horizontally, the cardboard was inserted in the window opening of the box-type enclosure used for series two and three tests. A translucent paper towel was taped to the back of the cardboard prior to each firing. The translucency of the paper enabled an observer, inside the enclosure, to observe spray hitting the eye area.

c. The test plan called for each of four firers to fire one burst from each of four dispersers, in two states of readiness, and from each of two distances. Repeat firings were made by two of the firers.

d. The firers included two females and two males. Neither of the female participants had had any prior experience with the devices; the male participants had had very limited experience with them, and this experience was only in practice roles. Each participant started with a full device and fired all four of his shots with this same device. For repeat firings, two shots were fired from each of the previously used devices.

e. Firing-readiness states were "ready" and "random." In the "ready" state, the firer had the projector in-hand, aimed, and ready-to-fire when the signal to fire was given. In the "random" state, when the signal to fire was given, the firer had to pick up the projector from a table beside him, "arm" the device by either pulling off the actuator covering cap or rotating the actuator to unlock position, aim, and then fire..

f. Firing ranges were 3 feet and 10 feet.

g. For each test, an observer with a stop watch stationed himself inside the enclosure, gave the start-fire and cease-fire orders, and took firing-duration-time measurements. The firer's target was the target "eyes," and the observer marked the elapsed time as soon as he saw spray hit the target. Firing-duration time, then, was the elapsed time between the start-fire order and the first observation of spray hitting the orbital area. Average times for the various devices and firing positions are given in Table 6. The test design, with observed firing times in seconds, is shown in Table 23A of the Appendix. The second set of times for the male firers are the replication firings which were run in the afternoon.

TABLE 6

Time to Engage Target as a Function of Range
(Time in Seconds, Ready Position)

Type of Projector	Agent	Firing Range 3 Feet	10 Feet
Federal Streamer No. 280	CN	1.0	1.8
DPC Paralyzer	CS	0.7	a
Penguin Stinger	Capsaicin	1.3	b
Army Experimental Device (XM36)	CR	1.3	1.8

[a]Did not reach 10 feet.

[b]Did not reach 10 feet in 65 percent of the tries.

h. Meteorological observations made during the testing period are shown in Table 24A of the Appendix.

i. The method used to select the firing sequence was to first select the order of the firers randomly, and then proceed to randomly select for each firer the order of:

(1) Devices

(2) Readiness Positions

(3) Ranges

Discussion of Results and Conclusions

1. The claim has been made by some that, when employing a hand-held, hand-activated pressurized disperser to subdue a person with CN, it is not necessary to actually hit the eye area with the spray. This would be due to the rapid vaporization of CN agent. Thus effects should still be achieved when the spray impacts on nearby areas of the body. However, the extremely low vapor concentrations observed in test series one, when used with the Edgewood Arsenal probability of incapacitation—time-concentration curves, indicates that the spray from these devices must be directed to the eye area to be effective. This contention is further supported by the vapor concentrations observed for the hand-held spray devices tested in test series one and three.

2. Opinions regarding the effects of the various tear gases on the eyes are not consistent, a fact which becomes very obvious when reading the vast literature available on the subject. However, investigators do agree that CN is more damaging to the eyes than CS—which, in turn, is probably more damaging than CR. Although CS does cause irritation to the eyes, it does not damage them permanently. Regardless of agent, however, the mechanical force that disperses it can injure the eye, particularly with misuse. Further, this damage should not be confused with the eye damage caused by "pens" or guns that dispense tear gas at high velocities. The total amount of agent directed into the eye, and the aid or treatment which follows, are also major considerations in predicting eye damage. It appears that at least a good study effort should be initiated to organize and analyze the data currently available on eye damage from tear gases. This is especially true because, in the "one-on-one" law-enforcement scenario, tear gas must be aimed at the eye to achieve a high assurance of effectiveness in the time periods required for operational usage.

3. After employing chemical agents against persons who have barricaded themselves in an enclosure (The Barricade-and-Hostage Scenario), the law-enforcement officer may be faced with the problem of when to enter. He would like to wait until reasonably sure that the occupants are incapable of violent resistance, but he must not wait until the occupants receive fatal dosages of the agent (particularly CN). With this in mind, estimates of response times for 84 percent probability of incapacitation and 1 percent probability of lethality have been obtained based on the average concentrations produced in the specified 5-minute sampling period by each chemical-incapacitating-agent dispersing device tested in test series two and three. These estimates are presented in Table 7. The following dosage values were used in arriving at the values of Table 7.

a. Concentration-time products expected to incapacitate 84 percent of those exposed (ICt 84) – 182 mg-min/cu m for agent CN and 22 mg-min/cu m for agent CS.

b. Concentration-time products expected to be lethal to 1 percent of those exposed (LCt 1) – 600 mg-min/cu m for agent CN and 3800 mg-min/cu m for agent CS.

TABLE 7

Times To Achieve Ict 84 And Lct 1 Values For
Average Concentrations Observed During Chemical
Test Series Numbers 2 And 3
Building Size - 8' x 8' x 8'

Device	Agent	First 5 Minutes			Second 5 Minutes		
		Average Conc. mg/cu m	Time To Achieve Ict 84 Sec.	Time To Achieve Lct 1 Min.	Average Conc. mg/cu m	Time To Achieve Ict 84 Sec.	Time To Achieve Lct 1 Min.
12 Ga. S&W Truflite Mark II	CS	31	45	123	7	-	543
AAI Ferret SGA 100	CS	22	59	173	9	420	422
Federal 514 Grenade	CS	275	11	14	77	23	49
Federal Flite Rite 530	CS	252	11	15	231	12	16
Chemical Mace Mark IV	CN	4	873	150	4	873	150
Federal Streamer 280	CN	5	747	120	4	875	150
Penguin Chemical Billy AG-20	CN	2	1,420	300	2	1,420	300
DPC Paralyzer	CS	1	2,309	600	0	-	-

As indicated, the columns in Table 7 marked "First 5 Minutes" and "Second 5 Minutes" present the average concentrations found in those time periods. Since concentrations will decay, the times found in these tables are conservative for the LCt 1 criteria. It is apparent that the larger sources (Federal 514 Grenade and the Federal Flite-Rite 530) produce rather rapid incapacitation (15 seconds) in the small inclosure, but the subjects should not be left within these concentrations for long time periods (10-15 minutes). It is also apparent from Table 7 that the hand-held aerosol projectors such as those tested pose no serious hazard when shot into a small room. The 12-gauge devices should be effective in approximately a minute, and like the projectors, pose no serious agent-hazard when fired into a small room.

4. Of the items tested in Series Four Tests, the Federal Streamer gave the overall shortest times to get "on target," while the Army experimental disperser (XM36) was second. The "Paralyzer" was good at the short ranges but, like the "Stinger," could not reach the 10-foot range. With crosswinds of 10 miles per hour, it was more difficult to get "on target" even with items which would reach 10 feet in still air. The Army experimental item had several "no fires"; that is, nothing happened when the button was first depressed. The times thus indicated were for the second try. In general, although the testing procedure was crude and simplistic, one could easily decide which of the four items he would procure for use under conditions represented by the test procedures. Hand-held pressurized projectors of the type used in these tests are not designed for fast, accurate usage except at very close range; an improved dispenser is needed.

5. The data collected and presented herein are sufficient for input to the general evaluation technique developed for chemical less-lethal weapons, as reported under Task IV (Modeling for Less Lethal Chemical Devices) of the basic LEAA/USAHEL Agreement.

APPENDIX

TEST INFORMATION, COMMENTS AND RESULTS

TABLE 1A

Series 1, Test 1: Data, Comments, and Results

Date of Test: 29 October 1974

Device Tested: Chemical Mace MK IV

Manufacturer: General Ordnance Equipment Corporation
P. O. Box 11211
Pittsburgh, Pennsylvania 15238

Active Agent: CN

Comments: Initial burst went over mannikin's right shoulder. No residue evident on target sampler. Firer Number 1.

Test Results

Amount of CN Impacted on Plate (Milligrams)	Average CN Vapor Concentration in First 15 Minutes (Milligrams/Cubic Meter)	
	Right	Left
11.23	0.3	0.3

TABLE 2A

Series 1, Test 2: Data, Comments, and Results

Date of Test: 29 October 1974

Device Tested: Chemical Mace MK IV

Manufacturer: General Ordnance Equipment Corporation
P. O. Box 11211
Pittsburgh, Pennsylvania 15238

Active Agent: CN

Comments: Sample time for vapor samplers questionable. Vapor samplers moved in closer to mannikin at +2 minutes. No residue evident on target sampler. Firer Number 2.

Test Results

Amount of CN Impacted on Plate (Milligrams)	Average CN Vapor Concentration in First 15 Minutes (Milligrams/Cubic Meter)	
	Right	Left
12.50	0.3	0.7

TABLE 3A

Series 1, Test 3: Data, Comments, and Results

Date of Test: 29 October 1974

Device Tested: Chemical Mace MK IV

Manufacturer: General Ordnance Equipment Corporation
P. O. Box 11211
Pittsburgh, Pennsylvania 15238

Active Agent: CN

Comments: Initial burst went to right of target. No residue left on target sampler. Firer Number 1.

Test Results

Amount of CN Impacted on Plate (Milligrams)	Average CN Vapor Concentration in First 15 Minutes (Milligrams/Cubic Meter)	
	Right	Left
9.70	1.2	0.2

TABLE 4 A

Series 1, Test 4: Data, Comments, and Results

Date of Test: 29 October 1974

Device Tested: Chemical Mace MK IV

Manufacturer: General Ordnance Equipment Corporation
P. O. Box 11211
Pittsburgh, Pennsylvania 15238

Active Agent: CN

Comments: No residue left on target sampler. Firer Number 2.

Test Results

Amount of CN Impacted on Plate (Milligrams)	Average CN Vapor Concentration in First 15 Minutes (Milligrams/Cubic Meter)	
	Right	Left
10.00	0.1	0.3

TABLE 5A

Series 1, Test 5: Data, Comments, and Results

Date of Test: 29 October 1974

Device Tested: Federal Streamer 280

Manufacturer: Federal Laboratories, Inc.
Saltsburg, Pennsylvania 15681

Active Agent: CN

Comments: Spray was initially to right of target and then to left before being zeroed in on target. Residue left on target. Firer Number 1.

Test Results

Amount of CN Impacted on Plate (Milligrams)	Average CN Vapor Concentration in First 15 Minutes (Milligrams/Cubic Meter)	
	Right	Left
15.49	0.1	0.2

TABLE 6A

Series 1, Test 6: Data, Comments, and Results

Date of Test: 29 October 1974

Device Tested: Federal Streamer 280

Manufacturer: Federal Laboratories, Inc.
Saltsburg, Pennsylvania 15681

Active Agent: CN

Comments: Spray was initially to right and then to left before being zeroed in on target. Residue left on target. Firer Number 2.

Test Results

Amount of CN Impacted on Plate (Milligrams)	Average CN Vapor Concentration in First 15 Minutes (Milligrams/Cubic Meter)	
	Right	Left
14.00	0.9	0.5

TABLE 7A

Series 1, Test 7: Data, Comments, and Results

Date of Test: 29 October 1974

Device Tested: Federal Streamer 280

Manufacturer: Federal Laboratories, Inc.
Saltsburg, Pennsylvania 15681

Active Agent: CN

Comments: Initial spray was off target 0.5 to 1 second. Residue left on target. Firer Number 1.

Test Results

Amount of CN Impacted on Plate (Milligrams)	Average CN Vapor Concentration in First 15 Minutes (Milligrams/Cubic Meter)	
	Right	Left
10.60	0.2	0.2

TABLE 8A

Series 1, Test 8: Data, Comments, and Results

Date of Test: 29 October 1974

Device Tested: Federal Streamer 280

Manufacturer: Federal Laboratories, Inc.
Saltsburg, Pennsylvania 15681

Active Agent: CN

Comments: Initial spray was off target 0.5 to 1 second. Residue left on target. Firer Number 2.

Test Results

Amount of CN Impacted on Plate (Milligrams)	Average CN Vapor Concentration in First 15 Minutes (Milligrams/Cubic Meter)	
	Right	Left
12.20	0.1	0.2

TABLE 9A

Series 1, Test 9: Data, Comments, and Results

Date of Test: 29 October 1974

Device Tested: Chemical Billy, AG 20

Manufacturer: Penguin Industries, Inc.
P. O. Box 97
Parkesburg, Pennsylvania 19365

Active Agent: CN

Comments: Initial spray went to right before being zeroed in on target. White residue left on target. Firer Number 1.

Test Results

Amount of CN Impacted on Plate (Milligrams)	Average CN Vapor Concentration in First 15 Minutes (Milligrams/Cubic Meter)	
	Right	Left
0.46	0.3	0.2

TABLE 10A

Series 1, Test 10: Data, Comments, and Results

Date of Test: 29 October 1974

Device Tested: Chemical Billy, AG 20

Manufacturer: Penguin Industries, Inc.
P. O. Box 97
Parkesburg, Pennsylvania 19365

Active Agent: CN

Comments: Clothing directly under target was very wet from overflow of liquid from target sampler. White residue left on sampler. Firer Number 2.

Test Results

Amount of CN Impacted on Plate (Milligrams)	Average CN Vapor Concentration in First 15 Minutes (Milligrams/Cubic Meter)	
	Right	Left
0.33	0.3	0.3

TABLE 11A

Series 1, Test 11: Data, Comments, and Results

Date of Test: 29 October 1974

Device Tested: Chemical Billy, AG 20

Manufacturer: Penguin Industries, Inc.
P. O. Box 97
Parkesburg, Pennsylvania 19365

Active Agent: CN

Comments: White residue was left on target. Firer Number 1.

Test Results

Amount of CN Impacted on Plate (Milligrams)	Average CN Vapor Concentration in First 15 Minutes (Milligrams/Cubic Meter)	
	Right	Left
0.40	0.7	0.2

TABLE 12A

Series 1, Test 12: Data, Comments, and Results

Date of Test: 29 October 1974

Device Tested: Chemical Billy, AG 20

Manufacturer: Penguin Industries, Inc.
P. O. Box 97
Parkesburg, Pennsylvania 19365

Active Agent: CN

Comments: Missed target initially for about one second. There was an odor similar to that of acetone. There were some eye effects upwind. White residue was left on sampler. Firer Number 2.

Test Results

Amount of CN Impacted on Plate (Milligrams)	Average CN Vapor Concentration in First 15 Minutes (Milligrams/Cubic Meter)	
	Right	Left
0.35	0.3	0.6

TABLE 13A

Series 2, Tests 1-3: Data, Comments, and Results

Date of Test: 15 October 1974

Time: 10:15 am - 11:30 am

Device Tested: Model 23 Tru-Flite MK II Barricade Penetrating Projectile

Manufacturer: Smith & Wesson Chemical Company
Rock Creek, Ohio 44084

Active Agent: CS

Device Functioning: Bursting-type ejection.

Number of Firings: 3

Total Sampling Time (Minutes - Each Firing): 10

Decontamination Period (Minutes - Each Firing): 15

Weather: Sunny - Temp. 70° - 74°F.; SW Winds @ 5 to 10 mph;
Relative Humidity 50 - 60%

Comments: Window pane broken by projectile's entry was not covered during sampling period following first firing. All rounds functioned well. Presence of some agent evident when enclosure was opened at end of each sampling period; however, there was no evidence of agent effects at the end of the decontamination periods. The floor of the enclosure was hosed down with water after these tests were completed and the enclosure was left open during lunch period.

Average Airborne Concentration of Agent (Milligrams/Cubic Meter)

At 5 Feet in 1st 5 Minutes	At 1 Foot in 1st 5 Minutes	At 5 Feet in 2nd 5 Minutes	At 1 Foot in 2nd 5 Minutes
31	30	9	6
40	33	5	7
34	45	6	10

TABLE 14A

Series 2, Tests 4-5: Data, Comments, and Results

Date of Test: 15 October 1974

Time: 1:00 pm - 2:15 pm

Device Tested: Ferret Liquid CS Barricade Penetrating Cartridge, Model SGA-100, 12 Gauge

Manufacturer: AAI Corporation
P. O. Box 6767
Baltimore, Maryland 21204

Active Agent: CS

Device Functioning: Bursting-type ejection.

Number of Firings: 2

Total Sampling Time (Minutes - Each Firing): 10

Decontamination Period (Minutes - Each Firing): 15

Weather: Sunny - Temp. 74°F.; SW Winds @ 5 to 10 mph; Relative Humidity 50%

Comments: Both rounds functioned well. Presence of some agent evident when enclosure was opened at end of each sampling period; however, there was no evidence of agent effects at the end of the decontamination periods.

Average Airborne Concentration of Agent (Milligrams/Cubic Meter)

At 5 Feet in 1st 5 Minutes	At 1 Foot in 1st 5 Minutes	At 5 Feet in 2nd 5 Minutes	At 1 Foot in 2nd 5 Minutes
21	28	9	17
22	23	8	10

TABLE 15A

Series 2, Test 6: Data, Comments, and Results

Date of Test: 16 October 1974

Time: 11:35 am - 12:00 noon

Device Tested: Model 23 Tru-Flite MK II Barricade Penetrating Projectile

Manufacturer: Smith & Wesson Chemical Company
Rock Creek, Ohio 44084

Active Agent: CS

Device Functioning: Bursting-type ejection.

Number of Firings: 1

Total Sampling Time (Minutes - Each Firing): 10

Decontamination Period (Minutes - Each Firing): 15

Weather: Intermittent Rain - Temp. 50°F.; NE Winds @ 0 to 5 mph; High Humidity

Comments: Device functioned well. Grazed top of window on entry. Agent presence was more noticeable when enclosure was opened after sampling period today than for same device yesterday.

Average Airborne Concentration of Agent (Milligrams/Cubic Meter)

At 5 Feet in 1st 5 Minutes	At 1 Foot in 1st 5 Minutes	At 5 Feet in 2nd 5 Minutes	At 1 Foot in 2nd 5 Minutes
14	17	2	8

TABLE 16A

Series 2, Test 7: Data, Comments, and Results

Date of Test: 16 October 1974

Time: 12:00 noon - 12:40 pm

Device Tested: Ferret Liquid CS Barricade Penetrating Cartridge
Model SGA-100, 12 Gauge

Manufacturer: AAI Corporation
P. O. Box 6767
Baltimore, Maryland 21204

Active Agent: CS

Device Functioning: Bursting-type ejection.

Number of Firings: 1

Total Sampling Time (Minutes - Each Firing): 10

Decontamination Period (Minutes - Each Firing): 15

Weather: Intermittent Rain - Temp. 50°F.; NE Winds @ 0 to 5 mph; High Humidity

Comments: Device functioned well. Agent presence was more noticeable when enclosure was opened after sampling period today than for same device yesterday.

Average Airborne Concentration of Agent (Milligrams/Cubic Meter)

At 5 Feet in 1st 5 Minutes	At 1 Foot in 1st 5 Minutes	At 5 Feet in 2nd 5 Minutes	At 1 Foot in 2nd 5 Minutes
11	26	2	9

TABLE 17A

Series 2, Tests 8-10: Data, Comments, and Results

Date of Test: 17 October 1974

Time: 9:35 am - 11:50 am

Device Tested: 514 Flame Proof Dust Grenade

Manufacturer: Federal Laboratories, Inc.
Saltsburg, Pennsylvania 15681

Active Agent: CS

Device Functioning: Bursting-type ejection.

Number of Firings: 3

Total Sampling Time (Minutes - Each Firing): 10

Decontamination Period (Minutes - Each Firing): 30

Weather: Sunny - Temp. 50° - 60°F.; High to Medium Humidity;
Winds: 1st Shot, Calm; 2nd Shot, NE, 0 to 5 mph;
3rd Shot, SW, 0 to 10 mph

Comments: Early morning dense fog covered area. Everything was extremely wet. Considerable time was spent drying interior of enclosure. Sun came through and dissipated fog before first shot. Device functioned well. Extremely strong concentration when enclosure opened at end of sampling period after each firing. Heavy brownish residue on floor and lower part of walls after each firing. Lower part of walls and floor of enclosure hosed down and swept after each test. Enclosure left open during lunch period.

Average Airborne Concentration of Agent (Milligrams/Cubic Meter)

At 5 Feet in 1st 5 Minutes	At 1 Foot in 1st 5 Minutes	At 5 Feet in 2nd 5 Minutes	At 1 Foot in 2nd 5 Minutes
407	685	82	81
128	145	52	102
170	115	63	84

TABLE 18A

Series 2, Tests 11-13: Data, Comments, and Results

Date of Test: 17 October 1974

Time: 1:00 pm - 2:30 pm

Device Tested: 530 Flite-Rite Barricade Projectile

Manufacturer: Federal Laboratories, Inc.
Saltsburg, Pennsylvania 15681

Active Agent: CS

Device Functioning: Burning - continuous visible smoke from ports over body of projectile.

Number of Firings: 3

Total Sampling Time (Minutes - Each Firing): 10

Decontamination Period (Minutes - Each Firing): 15

Weather: Sunny - Temp. 60°F.; SW Winds @ 10 mph;
Medium Relative Humidity

Comments: All rounds functioned well. First shot went through enclosure wall about one foot above window top. Concentration was so high that efforts to cover small hole produced by projectile were abandoned. Second shot went through enclosure wall at almost precisely the same spot as the first shot. The projectile entry hole was covered immediately (gas mask was donned by coverer prior to shot). Gas masks were worn by those opening enclosure after end of each sampling period due to extremely strong concentrations persisting at those times - enclosure was completely filled with dense white smoke.

Average Airborne Concentration of Agent (Milligrams/Cubic Meter)

At 5 Feet in 1st 5 Minutes	At 1 Foot in 1st 5 Minutes	At 5 Feet in 2nd 5 Minutes	At 1 Foot in 2nd 5 Minutes
191	195	161	219
457	273	187	255
190	207	323	238

TABLE 19A

Series 3, Test 1: Data, Comments, and Results

Date of Test: 15 October 1974

Time: 2:20 pm - 3:15 pm

Device Tested: Chemical Mace MK-IV

Manufacturer: General Ordnance Equipment Corporation
P. O. Box 11211
Pittsburgh, Pennsylvania 15238

Active Agent: CN

Device Functioning: Hand-held and hand-actuated pressurized disperser.

Number of Firings: 1

Total Sampling Time (Minutes - Each Firing): 36

Decontamination Period (Minutes - Each Firing): 15

Weather: Sunny - Temp. Mid-70°F.; SW Winds @ 5 mph;
Relative Humidity 50%

Comments: Device functioned well. Duration of emission was 37 seconds. Agent presence was noticeable when enclosure was opened at end of sampling period.

Average Airborne Concentration of Agent (Milligrams/Cubic Meter)

	At 5 Feet in 1st 18 Minutes	At 1 Foot in 1st 18 Minutes	At 5 Feet in 2nd 18 Minutes	At 1 Foot in 2nd 18 Minutes
Vapor	6	2	3	4
Aerosol	0	0	0	0

TABLE 20A

Series 3, Test 2: Data, Comments, and Results

Date of Test: 15 October 1974

Time: 3:15 pm - 4:00 pm

Device Tested: Federal Streamer 280

Manufacturer: Federal Laboratories, Inc.
Saltsburg, Pennsylvania 15681

Active Agent: CN

Device Functioning: Hand-held and hand-actuated pressurized disperser.

Number of Firings: 1

Total Sampling Time (Minutes - Each Firing): 36

Decontamination Period (Minutes - Each Firing): Last firing of the day.

Weather: Sunny - Temp. Mid-70°F.; SW Winds @ 5 mph;
Relative Humidity 50%

Comments: Device functioned well. Duration of emission was 60 seconds. Agent presence was noticeable when enclosure was opened at end of sampling period.

Average Airborne Concentration of Agent (Milligrams/Cubic Meter)

	At 5 Feet in 1st 18 Minutes	At 1 Foot in 1st 18 Minutes	At 5 Feet in 2nd 18 Minutes	At 1 Foot in 2nd 18 Minutes
Vapor	7	3	4	3
Aerosol	0	0	0	0

TABLE 21A

Series 3, Test 3: Data, Comments, and Results

Date of Test: 16 October 1974

Time: 9:25 am - 10:20 am

Device Tested: Chemical Billy, AG 20

Manufacturer: Penguin Industries, Inc.
P. O. Box 97
Parkesburg, Pennsylvania 19365

Active Agent: CN

Device Functioning: Hand-held and hand-actuated pressurized disperser.

Number of Firings: 1

Total Sampling Time (Minutes - Each Firing): 36

Decontamination Period (Minutes - Each Firing): 15

Weather: Intermittent Rain - Temp. 50°F.;
Low Wind; High Humidity

Comments: Device functioned well. Agent presence was noticeable at end of sampling period.

Average Airborne Concentration of Agent (Milligrams/Cubic Meter)

	At 5 Feet in 1st 18 Minutes	At 1 Foot in 1st 18 Minutes	At 5 Feet in 2nd 18 Minutes	At 1 Foot in 2nd 18 Minutes
Vapor	1	2	1	3
Aerosol	0	0	0	0

TABLE 22A

Series 3, Test 4: Data, Comments, and Results

Date of Test: 16 October 1974

Time: 10:20 am - 11:35 am

Device Tested: DPC Paralyzer

Manufacturer: Defense Products Manufacturing Corporation
1628 South Hanley Road
St. Louis, Missouri 63144

Active Agent: CS

Device Functioning: Hand-held and hand-actuated pressurized disperser.

Number of Firings: 1

Total Sampling Time (Minutes - Each Firing): 36

Decontamination Period (Minutes - Each Firing): 30

Weather: *Intermittent Rain - Temp.* 50°F.; NE Winds @ 0 to 5 mph; High Humidity

Comments: Device functioned well. Duration of emission was 34 seconds. No evidence of presence of CS when enclosure was opened at end of sampling period; however, the floor of the enclosure was very slippery - possibly from oil solution of CS. Floor was hosed down with water after completion of test.

Average Airborne Concentration of Agent (Milligrams/Cubic Meter)

	At 5 Feet in 1st 18 Minutes	At 1 Foot in 1st 18 Minutes	At 5 Feet in 2nd 18 Minutes	At 1 Foot in 2nd 18 Minutes
Vapor	0	0	0	0
Aerosol	1	0.5	0	0

TABLE 23A

Test Design With Observed Times In Seconds
Test Series 4

Firer	Position	Device / Range	Federal Streamer CN				DPC Paralyzer CS				Penguin Stinger Capsaicin				Army Experimental Device CR (XM36)			
			3 ft		10 ft		3 ft		10 ft		3 ft		10 ft		3 ft		10 ft	
Male 1	Ready		1.1	1.5	1.4	2.3	0.9	0.8	-	-	0.9	1.5	2.0	-	1.0	1.2	2.0	1.9
	Random		2.3	2.7	3.0	3.5	2.0	2.0	-	-	2.4	2.3	4.0	3.2	2.2	2.2	3.0	2.5
Male 2	Ready		0.6	0.7	1.6	2.2	0.8	0.8	-	*10+	0.9	2.2	1.9	-	1.6	2.9	1.3	2.3
	Random		2.6	3.5	3.6	3.6	2.0	2.5	-	-	2.7	2.8	3.3	6.2	2.5	2.9	3.6	4.1
Female 1	Ready		0.9		1.2		0.2		-		1.2		*10+		0.8		2.2	
	Random		2.3		2.8		1.7		-		2.6		*10+		2.3		3.8	
Female 2	Ready		0.9		1.9		0.6		-		0.9		5.1		0.3		1.3	
	Random		2.2		2.3		1.2		-		2.2		-		1.9		3.2	

- Did not reach.
* Did not reach but recorded time indicates spray time attempting to reach target.

TABLE 24A

Meteorological Observations Made During Testing Period
Test Series 4

Time	Winds		Temperature °F.	Relative Humidity, %
	Direction	Speed MPH		
0900	NE	1-2	37	56
1000	↓	5	39	-
1100	↓	0-6	43	70
1200	↓	2-5	45	-
1300	↓	2-6	45	-
1400	↓	3-11	47	66
1600	↓	0-6	46	-